

Cerebral Cortex in the Control of Skin Temperature in Man

Sumio Uematsu, M.D., F.A.C.S.

●Experimental and clinical evidence suggests that the cerebral cortex may control the vasomotor tone of the skin as part of body temperature regulation. Previous evidence has been based on animal experiments and clinical observations, but the findings of animal experiments were troubled with wide variation among animals and may not be directly applicable in man. The clinical observations were obviously limited for technical reasons. Currently, however, computerized thermography and CT or MRI (magnetic resonance imaging) of the human brain provide an opportunity to explore the link between the cerebral cortex and skin temperature.

Skin temperature differences (ΔT) between one foot and its opposite counterpart were $0.05 \pm 0.44\text{C}$ in 29 control subjects, $0.08 \pm 0.19\text{C}$ in 4 patients with temporal lobe epilepsy ($p = .9$), and $0.63 \pm 1.22\text{C}$ in 8 patients with brain tumor ($p < .02$). The skin temperature of the plantar aspect of the foot contralateral to the cerebral lesion was warmer in 6 of 8 patients. In one patient, the contralateral foot was 1.3C colder. In another patient, who had a lesion occupying the posterior temporal lobe, the skin temperature was equal between the feet. Preliminary observations suggest that the cerebral cortex outside of the hypothalamus is linked to cutaneous sympathetic vasomotor tone.

Introduction

One hundred years ago, on Saturday, May 18, 1889, Victor Horsley read a paper entitled "Clinical Observation on the Value of Differences in the Temperature of the Two Sides of the Body as Symptomatic of Cerebral Lesion" at the Neurological Society of London (Fig. 1).¹ In Horsley's time, surgeons began to attempt to localize brain lesions based on neurological findings. For example, in patients with aphasia, the frontal inferior convolution was exposed. In a patient with focal motor seizure, the paracentral convolutions were explored. Surgeons had been keenly interested in knowledge of the cerebral cortex ever since the discovery of the speech center of the brain by Broca in 1861² and the march of focal motor seizures by Hughings Jackson in 1862.³ Their interest was accelerated by subsequent demonstration of the motor cortex by electrical stimulation in animals by Fritsch and Hitzig in 1870.⁴ Ten

years after Victor Horsley's presentation, C. L. Allen, Senior Clinical Professor of the Georgetown University, reported a case that manifested with edema of the paralyzed limbs in a hemiplegic patient. Autopsy disclosed an old hematoma in the entire hemisphere, extending from the frontal to the occipital lobe.⁵

It is of interest to note that the knowledge of neurophysiology that has contributed so greatly to representation of the somatomotor and sensory cortex has not been exploited regarding cutaneous vasomotor representation on the cortex. This paper reviews past and current knowledge of the subject and reports preliminary observations on skin temperature measurement in patients with unilateral brain lesion.

Review of Literature

Table 1 lists experimental observations on skin temperature changes after ablation or electrical stimulation of the brain in animals and man.

Pinkston et al.⁶ noted that immediately after the removal of one cerebral hemisphere or of the motor-sensory area of one side in the dog, the contralateral side of the body was appreciably warmer to touch. No accurate measurements were made, however, until 2 to 4 weeks after the operation, by which time the difference in temperature between the two sides had disappeared in a number of the dogs. However, a few animals continued to show the change for long periods (e.g., 4 months after removal of the right cerebral cortex, dog 8 had a skin temperature of 32.67C on the right side and 33.36C on the left). Localization of this phenomenon to the motor-sensory area of the cortex is suggested by experiments on dog 6. Twenty-eight days after the first operation (ablation of the left motor-sensory area), the skin temperature on the right was 35.94C , while on the left it was 35.06C (Table 2).

Similar ablation experiments were carried out by Schwartz in 1935.⁷ Schwartz measured the "psychogalvanic reflex" (electrical skin resistance). After ablation of the prefrontal or premotor area of the cat's brain, the electrical resistance of the skin was decreased, due to increased sweating in the contralateral limbs.

In 1936, Green and Hoff undertook electrical stimulation of the precentral cortex, which increased the volume of the contralateral limbs in cats and monkeys. The investigators concluded that the increased volume

From the Department of Neurosurgery, Johns Hopkins University School of Medicine, Baltimore, Maryland.

This paper was read at the 18th Annual Meeting of the American Academy of Thermology, Washington, D.C., May 18, 1989.